Calculation of potential flow around bodies

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SUMMARY

This thesis concerns the calculation of the potential flow around two- and three-dimensional bodies where the onset flow is a given uniform stream. For three-dimensional bodies only the nonlifting potential flow is considered.

The potential flow around a body can be obtained as the superposition of the uniform stream and a flow generated by a doublet distribution at the body surface and in the wake. The condition that on the body surface the normal component of fluid velocity must vanish, leads to an integral equation for the unknown doublet distribution. This integral equation is solved numerically. The body surface and the doublet distribution are approximated separately with the aid of cubic or doubly cubic splines. A proper choice of coordinates in these approximations guarantees a correct representation near important points such as the leading and the trailing edges, and allows application of the Kutta condition exactly at the trailing edge. This is especially important in view of the significance of the Kutta condition in controlling the circulation. The doublet distribution is finally specified with the aid of a collocation method. The numerical integrations are considered in detail.

Results of this method were compared with analytically obtained results for airfoils generated by conformal mapping from a circle. Additional results are given for a number of ellipsoids and for a finite wing. In comparison with other methods the present method leads to more accurate results and a considerable saving in computer storage and time. Furthermore, the fast convergence of the numerical results allows reliable error estimates to be made.